United Nations E/CN.17/2006/3

Economic and Social Council

Distr.: General
17 February 2006

Original: English

Commission on Sustainable Development
Fourteenth session
1-12 May 2006
Item 3 of the provisional agenda*
Thematic cluster for the implementation cycle 2006-2007 — review session

Energy for sustainable development, industrial development, air pollution/atmosphere and climate change: integrated review of progress in meeting the goals, targets and commitments of Agenda 21, the Programme for the Further Implementation of Agenda 21 and the Plan of Implementation of the World Summit on Sustainable Development

Report of the Secretary-General**

Summary

Energy for sustainable development, industrial development, air pollution/atmosphere and climate change are closely interlinked. Energy is essential to poverty reduction and economic development, including industrial development. At the same time, fossil fuel combustion for energy, industry and transport is a major source of air pollution and greenhouse gas emissions. Addressing in an integrated manner the sustainable development challenges relating to all four issues under review in the current implementation cycle can serve to enhance synergies, seize win-win opportunities and minimize trade-offs where they exist.

* E/CN.17/2006/1.

** Submission of this report was delayed to reflect the outcomes of regional implementation meetings.

06-24718 (E) 080306

The World Summit on Sustainable Development in 2002 stressed the importance of access to energy for the alleviation of poverty. Though some progress has been achieved since then, especially on improving access to electricity, 2.4 billion people have no access to modern energy services, and one quarter of the world population lives without electricity. Ninety per cent of rural households rely on traditional energy sources for cooking and heating with associated indoor air pollution. Barriers to energy access by the poor include inability to pay high upfront costs of end-user equipment, including improved cooking stoves, and electricity tariffs designed for full cost recovery.

Concerns over energy security have been heightened with the recent significant increase in energy prices. Addressing the world's growing demand for energy resources and ensuring the reliability of global energy supplies on a fair and stabilized energy market calls for comprehensive and integrated policies that consider both demand and supply aspects, as indicated in the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation"), as well as cooperation by all countries, developed and developing, energy-importing and -exporting.

Some developing countries have experienced significant economic growth rates in recent years largely owing to rapid industrial development and their ability to benefit from globalization. Others have not, in particular the least developed countries and some small island developing States. Barriers to industrial development often include inadequate infrastructure and human capacities and lack of incentives for private investment. Energy-efficiency technologies offer win-win opportunities for lowering production costs and reducing air pollution and climate change simultaneously. Encouraging end-use energy efficiency has met with some success. However, affordability remains a challenge for poorer developing countries, and ensuring technology transfer to these countries is often problematic.

Energy use for power generation, in industry and for transport, particularly from fossil fuels, releases large amounts of air pollutants and carbon dioxide into the atmosphere, and new energy technologies are expected to play a vital role in controlling emissions, along with changes to unsustainable patterns of consumption and production called for in the Johannesburg Plan of Implementation and the 2005 World Summit. Developing countries, particularly least developed countries and small island developing States, are especially vulnerable to the adverse impacts of climate change, which impedes efforts to overcome poverty and achieve sustainable development.

There has been some progress in meeting objectives of the Johannesburg Plan of Implementation regarding these four issues at the national, regional and international levels, including by World Summit on Sustainable Development partnerships, but barriers and constraints remain. Improving the means of implementation, including through better financing and facilitating technology transfer, could promote the achievement of Agenda 21 and World Summit goals specific to those issues, as well as related sustainable development goals and the Millennium Development Goals, including poverty alleviation.

Contents

		Paragraphs	Page
I.	Introduction	1–2	5
II.	Interlinkages among energy for sustainable development, industrial development, air pollution/atmosphere and climate change	3–8	5
III.	Energy for poverty eradication and social and economic development	9–20	7
	A. Access to modern energy services	9–13	7
	B. Promoting electrification	14-18	9
	C. Initiatives to support access to clean energy services	19–20	12
IV.	Towards sustainable industrial development	21–36	12
	A. Industrial development, growth and poverty reduction	22–27	12
	B. Efficient and cleaner industrial development	28–35	14
	C. Strengthening corporate environmental and social responsibility and accountability	36	17
V.	Energy efficiency for enhanced competitiveness, better air quality and climate change mitigation	37–49	17
	A. Energy efficiency in industry	39–40	19
	B. Efficiency in the energy sector	41–42	20
	C. Transport sector efficiency potential	43–45	22
	D. Measures to promote energy efficiency	46–49	23
VI.	Cleaner energy technologies for reducing air pollution and greenhouse gas emissions	50–63	24
	A. Renewable energy technologies	51–56	25
	B. Advanced fossil fuel technologies	57–59	28
	C. Other advanced energy technologies	60–63	29
VII.	Meeting financing needs for energy, industrial development and emissions reduction	64–79	30
	A. Stimulating investment in energy infrastructure and services	66–73	31
	B. Funding climate change mitigation and adaptation	74–79	33
VIII.	Subregional, regional and international cooperation	80–92	37
	A. Energy security	80–84	37
	B. Subregional and regional cooperation	85–88	38
	C. International cooperation	89–92	40
IX.	Continuing challenges	93–100	42

Page

List of tables

1. Electrification rates by region for 2000 and 2002 10
2. Renewable energy from world geothermal, solar, wind, and wood and waste for electric power consumption by region for 2000 and 2003 25
3. Existing global capacities in 2004 and average annual growth rates from 2000 to 2004 for energy from selected renewable sources 26
4. Required energy investment by region, 2001-2030 32
5. Required world energy investments by energy type, 2001-2030 32

List of figures

I. Electricity access by the richest and poorest 40 per cent of households in selected developing countries 9
II. Energy intensity of industry by region 20
III. Extent of cogeneration in selected countries in 2004 21
IV. World fuel ethanol and biodiesel production by region, 2000-2003 23
V. Cost ranges for heating and grid power using selected renewable energy technologies 27
VI. Global Environment Facility portfolio investments in climate change 36

List of boxes

1. Gender and energy access 8
2. Electrifying rural households in Morocco 11
3. Promoting clean production 15
4. Energy efficiency potential for reducing greenhouse gas emissions 19
5. Implementation of the World Solar Programme 1996-2005 28
6. Pollution control technology for coal-fired power plants 29
7. Clean Development Mechanism 34
8. Convention on Long-range Transboundary Air pollution: a model for reducing transboundary air pollution 39
9. International cooperation for combating ozone layer depletion 41
10. Sub-Saharan Africa eliminates leaded fuels 42

I. Introduction

1. At its eleventh session, the Commission on Sustainable Development decided on a multi-year programme of work and selected for the second implementation cycle the issues of energy for sustainable development, industrial development, air pollution/atmosphere and climate change for its fourteenth and fifteenth sessions. The General Assembly, in its resolution 60/194, and the Commission, at its thirteenth session (see E/CN.17/2005/12), decided to consider issues concerning small island developing States, and a forthcoming report (E/CN.17/2006/7) will review progress made on the thematic cluster of the fourteenth session of the Commission as it relates to these countries. The present report reviews the progress of implementation related to the four issues of this thematic cluster and addresses the challenges and opportunities for implementing Agenda 21 and the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation") in an integrated manner, with a focus on the economic, social and environmental pillars of sustainable development. Specific attention is given to strengthening the means of implementation.

2. This report incorporates the outcomes of the regional implementation meetings and draws on relevant case studies and lessons learned and on national reports and assessments received from Governments, contributions received from United Nations regional commissions, programmes and specialized agencies, and inputs from major groups, as well as the latest information and data available to the Secretariat.

II. Interlinkages among energy for sustainable development, industrial development, air pollution/atmosphere and climate change

3. Interlinkages among energy for sustainable development, industrial development, air pollution/atmosphere and climate change imply that measures and actions taken to address one issue often have benefits in the other areas. Moreover, as recognized by the World Summit on Sustainable Development in 2002 and the 2005 World Summit, progress on these issues is fundamental to achieving the Millennium Development Goals. In particular, progress towards the goal of eradicating poverty would be furthered by improving access to energy by the poor, stimulating industrial development and abating emissions that can damage health, reduce crop yields and contribute to climate change.

4. Socio-economic development requires energy for improved living standards, enhanced productivity, the transport of goods to markets and as input to a wide range of other economic activities. The transition from traditional energy sources — notably traditional biomass — to modern energy sources is associated with a variety of social benefits, including improving the health, well-being and income-generating opportunities of women and facilitating access to employment, education and social services in both urban and rural areas. Extending access to affordable, cleaner energy is thus integral to the process of social and economic development. It contributes to addressing the cross-cutting issues of poverty eradication, improved health and gender equity.

5. Energy-efficiency technologies offer win-win opportunities to lower production costs, enhance energy security and reduce air pollution and greenhouse gas emissions simultaneously. However, affordability remains a challenge for poorer developing countries and transferring technology to these countries is often problematic. Governments are critical actors in setting policies that provide appropriate incentives for more energy-efficient, less polluting economic activities and increased access to modern energy services. Modern technologies require highly educated and trained personnel to operate effectively, and many developing countries lack the requisite technical and human resources.

6. Adverse impacts from climate change could affect not only ecosystems, but also social and economic systems, threatening to undermine sustainable development. There is growing evidence that anthropogenic emissions are a major cause of global warming. If effective action is not taken to reverse the current trend of emissions growth by 2030, there may be irreversible changes to the climate system. Carbon dioxide (CO_2) emissions from energy and industry by developed countries increased between 1990 and 2003 by between 14 and 15 per cent according to the International Energy Agency, and the current developed country share of global emissions amounts to 47 per cent. Overall carbon dioxide emissions are likely to increase by 62 per cent by 2030, with more than two thirds expected from developing countries. Climate affects the frequency of natural disasters. Developing countries, particularly the small island developing States and least developed countries, are especially vulnerable to adverse impacts of climate change and, without adequate investments in adaptation, their vulnerability will increasingly impede efforts to overcome poverty and achieve sustainable development. Even as countries prepare for adaptation, it is essential to control anthropogenic greenhouse gas emissions, which contribute to climate change.

7. In meeting the climate change challenge, a broad range of measures for both mitigating climate change and adapting to its adverse effects are required. These include further energy efficiency improvements, new energy and carbon capture and storage technologies, changes to unsustainable patterns of consumption and production and coastal zone management and agricultural practices. While some progress has been achieved supporting mitigation activities, providing adequate funding to support adaptation activities remains a challenge. Adaptation is important for both developed and developing countries, and multilateral support to countries that are most vulnerable to climate change is needed. Furthermore, linking the climate change agenda to the broader development agenda and promoting science-based decision-making at the global and national levels are challenges.

8. Actions on these four issues are often enhanced by addressing the interlinkages among them; for instance, promoting cleaner and more energy-efficient industrial technologies can yield benefits for air quality as well as for climate change mitigation. Enhancing the means of implementation cuts across all four issues, as financing, technology, capacity-building and the ability to craft effective and efficient policies and measures are common to addressing all the challenges in this thematic cluster.

III. Energy for poverty eradication and social and economic development

A. Access to modern energy services

9. The importance of modern energy services for achieving sustainable development and the Millennium Development Goals, in particular the goal of halving the proportion of people living in poverty, was affirmed at the World Summit on Sustainable Development, resulting in the Johannesburg Plan of Implementation commitment to improve access to reliable and affordable energy services. Since that Summit, due to population growth and persistent poverty in much of the developing world, the estimated number of people without access to modern energy services has increased. Worldwide, an estimated 2.4 billion people — approximately half of all households and 90 per cent of rural households — rely for cooking and space heating on traditional, non-commercial energy sources, including charcoal, wood, agricultural residues and dung.

10. Sustained high prices raise particular energy security concerns for least developed countries and small island developing States that must import energy and can often least afford to pay higher prices. In general, developing countries with economies facing high debt repayment burdens and weak export earnings will face greater challenges as foreign exchange costs for oil and other energy imports rise. There is a risk that progress in reducing dependence on traditional, dirty biomass fuels may be slowed or reversed as the poor face higher prices for liquefied petroleum gas and kerosene. Also, Governments that choose to continue to subsidize fossil fuels like kerosene or gasoline face a heavier fiscal burden with higher oil prices.

11. For those without access to modern energy services, reliance on traditional fuels imposes an especially heavy burden on women and children. Negative consequences include respiratory infections in children below five years of age, which annually account for almost 2 million deaths (greater than the number of deaths from diarrhoeal diseases in that age group),[1] and a significant health burden on women from cooking with traditional fuels on poorly vented stoves. Countries in Africa and Asia report the highest fatalities due to indoor smoke from solid fuels. Collecting biomass is a time-consuming and tiring task which also often results in environmental degradation with both local and global consequences. Collecting fuel is customarily the task of women and children, which interferes with child-care and/or potential income-generating activities of the former and educational opportunities of the latter. Thus, improving access to modern energy services can make an important contribution to the goal of gender equality and empowerment of women.

12. Evidence indicates that the poor, particularly in urban areas, spend a larger percentage of their incomes on energy services than higher income groups and that costs per unit of energy are higher for the poor. This is partly because, with limited cash resources, poor people tend to buy charcoal, fuelwood and kerosene in smaller amounts at higher unit cost and partly because they use less efficient cooking technologies. Barriers to energy access and affordability arise from inefficient public service providers and the lack of incentives for private sector companies to serve the poor. As identified at the African regional implementation meeting for the

fourteenth session of the Commission, other constraints to access include existing taxes on modern fuels and limited financial resources available for energy investment.[2] The cost of electricity grid extension poses a particularly high barrier in rural areas, while for the urban poor affordability is the main constraint.

Box 1
Gender and energy access

Traditional gender roles mean that men and women tend to use energy for different purposes and manage its use differently. Fuelwood collection and cooking are dominant among the domestic chores of women, but the focus of energy in men's lives is for income-generating activities outside the home. The decision-making process affecting the design of energy projects tends to be dominated at the community and institutional levels by men, with little consultation to determine the energy needs or the income-generating potential of women. These are rarely addressed in the development of energy projects for advancing sustainable development. This failure can lead to projects that neglect basic household needs and underemphasize the income-generating potential of women. A more thorough understanding of men's and women's needs for and potential uses of energy could ensure that the goals of energy-related projects are realized equitably for women and men, with greater benefits to families and their community and a more focused approach to implementing Agenda 21 and the Johannesburg Plan of Implementation.

Source: "Supporting Gender and Sustainable Energy Initiatives in Central America, Volume I", ESMAP Technical Paper 061, World Bank, 2004.

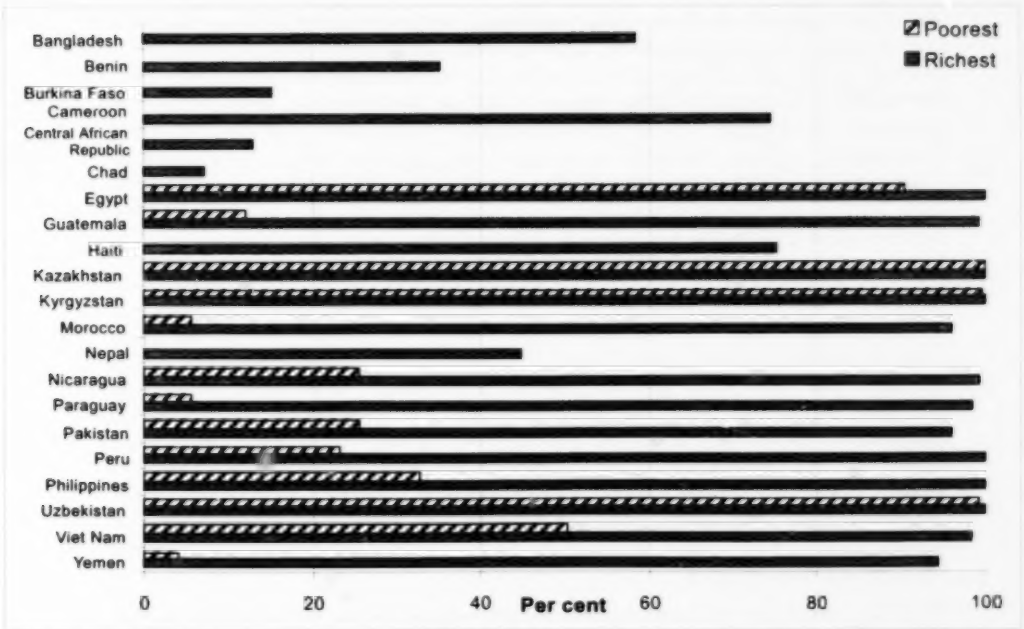
13. At the local/village level, options for cooking and space heating that reduce indoor air pollution and increase efficiency include improved woodstoves, liquid petroleum gas stoves and biogas digestors. Kerosene, biogas (primarily methane), liquefied petroleum gas (primarily propane) and butane are common fuels for cooking and heating and many times more efficient than traditional fuels. Liquefied petroleum gas use increased annually by 2.1 per cent from 1999 to 2004, largely owing to increased use in developing countries.[3] The tendency for people to move up the "energy ladder", using more efficient and generally cleaner fuels and energy services as incomes rise, can be spurred by programmes and projects that contribute to rural area and slum improvement in general. A number of national and international efforts aim at increasing the use of clean and safe cooking and heating practices, particularly in rural areas, including in Nepal, where more than 100,000 improved cookstoves were provided.[4] Other programmes encourage liquefied petroleum gas use for cooking, producing biogas from organic wastes, and substituting liquefied petroleum gas, kerosene or butane for wood in an effort to preserve the environment and to improve indoor air quality. In Africa, efforts to introduce multifunction platforms (small engines mounted on chassis to power a variety of end-use equipment) have proven successful in stimulating small-scale agricultural-processing activities in rural areas.

B. Promoting electrification

14. Though electricity access is essential to achieve sustainable development, including industrial development, and the Millennium Development Goals, approximately one quarter of the world population (one third of the population of developing countries) lives without access to electricity despite recent progress in some areas. Figure I on electricity access by the richest and poorest 40 per cent of the population in selected countries and table 1 on electricity access by region indicate the extent of inequalities in access within and across countries and regions. China accounted for much of the worldwide success in electrification achieved since 1990 in large part by increasing generation capacity utilizing a variety of proven technologies. Sub-Saharan Africa and South Asia are most in need of efforts to expand generation capacity. It is estimated that, without new policies and major new investments, 1.4 billion people will remain without access to modern energy services in 2030.[5]

Figure I

Electricity access by the richest and poorest 40 per cent of households in selected developing countries



Source: World Bank Living Standard Measurement Survey data.

Table 1
Electrification rates by region for 2000 and 2002
(In percentage)

Region	*2000*	*2002*
Africa	34.3	36
North Africa	90.3	94
Sub-Saharan Africa	22.6	24
South Asia	40.8	43
East Asia and the Pacific	86.9	88
Latin America	86.6	89
Middle East	91.1	92
Developing countries (total)	64.2	66

Source: International Energy Agency, *World Energy Outlook*, 2002 and 2004, OECD/IEA (2002/2004).

15. Once adequate generating capacity exists, the cost of grid electricity distribution depends on the cost of transmission line construction, distance from the transmission line and population density. Rural areas where villages are closely spaced and densely populated, as in India, are cheaper to electrify than those with lower densities, as in the Sahel region of Africa. Transmission line construction represents the biggest cost associated with grid connection. This cost can vary dramatically — from US$ 2,000 in India to US$ 18,000 in Mali — for a similarly configured kilometre of mid-voltage line. Electrification initiatives in South Africa and Tunisia provide evidence that costs can be reduced through efficiencies, appropriate standards and suitable technology choices.

16. Transborder interconnection of national electricity grids offers considerable benefits in fuel savings, avoided capital costs for additional generation capacity and lower operating costs of generation and transmission facilities. Interconnected grids exist in Europe, the countries of the former Soviet Union, North America, South America and West Asia, and are planned or are under construction in Central America, South-East Asia and parts of Africa. As discussed at the Economic Commission for Latin America and the Caribbean regional implementation meeting, however, there remains significant underutilization of regional generating capacity, hence potential benefits from closer regional energy cooperation. Grid interconnection also holds potential benefits for Africa, especially with the development of hydropower resources, as the success of the Southern Africa Power Pool project demonstrates.

17. Renewable energy technologies also offer opportunities for improving access to energy in rural and remote areas where widely dispersed populations render grid connection too expensive. The 1,710 solar home systems installed on 18 islands of Kiribati provide solar lighting in remote areas.[6] About 250,000 households in China use recently installed solar photovoltaic, wind-solar photovoltaic and other hybrid systems. Renewable energy use in rural areas has been encouraged by subsidizing capital costs, while covering operating costs with end-users fees. An important advance is the use of renewable sources of energy to power mini-grids. Renewable

energy based mini-grids, including those powered with solar photovoltaic, wind, geothermal and biomass energy, are feasible in many areas and are considered more reliable than household units. Also, small hydropower systems are an option. China has had success in promoting small-scale hydropower systems in remote and mountainous areas with national government grants supplemented by local government funding for building facilities. Small hydropower systems of less than 50-megawatt (MW) capacity now account for one third of all hydropower systems in China and have served more than 500 million people over time, many of whom are now served by grid connections.[7] Once built, user fees generally cover operating costs. Village mini-grids also provide energy access elsewhere, including in India, Nepal, Sri Lanka and Viet Nam, in remote areas or on isolated islands. Measures to encourage village mini-grids where feasible, such as government-supported financing to cover capital expenses, have been successful and could be replicated.

Box 2
Electrifying rural households in Morocco

A joint venture between Morocco's National Electricity Office, Electricité de France, Total and Tenesol, a solar photovoltaic technology manufacturer, is attempting to provide remote Moroccan villages with electricity access through solar power installations. It is part of an overall programme to create small, locally run companies that provide rural services including electricity, water, gas and telephone services in order to stimulate local economic activity and contribute to wealth generation. For producing its own electricity, each house is fitted with a solar home power system using equipment tailored to the main requirements of rural households, such as lighting and audio-visual appliances. The project emphasizes long-term services that go beyond simple installation, including upgrading to power more sophisticated appliances such as refrigerators. Although the average cost of an installed system is approximately US$ 800, a grant covering 66 per cent and additional financing through shareholders covering 24 per cent leave the customer with only 10 per cent to pay. The project has benefited from support in the form of equipment from the National Electricity Office financed by a US$ 6.5 million grant from the German KfW Bank Group and a US$ 6.5 million soft loan from the French Development Agency. Support was also provided in the start-up phase by the French Fund for the World Environment.

Source: World Business Council for Sustainable Development.

18. Locally available energy sources may also include small-scale fossil fuel reserves that can be exploited. There are many locations where pockets of natural gas occur in quantities too small for the export market, but large enough for domestic use. Small and medium enterprises can be instrumental in developing local resources if adequate legal and institutional structures are in place. As with village mini-grids, government support can encourage the exploitation of these reserves.

C. Initiatives to support access to clean energy services

19. As their incomes rise, people tend to shift to cleaner modern energy sources. In turn, once modern energy services are widely available and affordable, economic growth and social well-being are enhanced. Until people can afford to purchase cleaner, more efficient energy, government and international programmes will be the main vehicles for improving the quality of fuels and energy services. At the national level, cross-subsidies, whereby higher-income users are charged a higher rate to cover costs of lower-income users, have been effective in improving access to electricity by the poor without negatively affecting the financial solvency of electricity companies. The effectiveness of development efforts can be enhanced by programmes that integrate multiple goals and benefits. Thus, improved energy efficiency, reduced deforestation and better air quality can be achieved under a single programme to improve cooking and heating techniques.

20. At the international level, efforts to address access to energy and reduce indoor air pollution include the Global Village Energy Partnership and the Partnership for Clean Indoor Air. Both networks have expanded activities since the World Summit on Sustainable Development. Commitments to action for improving energy access were facilitated by the 2004 Energy for Development conference organized by the Government of the Netherlands in Noordwijk. To improve energy access for the poor, the European Union (EU) Energy Initiative recently committed €250 million for energy access in the African, Pacific and Caribbean regions, leveraging resources from the private sector, financial institutions, civil society and end-users.

IV. Towards sustainable industrial development

21. Ensuring that expansion of electricity supplies keeps pace with the needs of industry is a major challenge for rapidly industrializing economies. National grid electricity service is often intermittent. Faced with costly power interruptions, many industrial establishments invest in their own generating capacity, often using polluting and less efficient diesel generators. As a stop-gap measure, some governments rely on self-contained industrial zones or estates to overcome the broader deficiencies of infrastructure like electricity and telecommunications. While such enclaves may be helpful at early stages of industrial development, they cannot serve as the basis for a long-term and broad-based industrial development strategy. Some countries such as Egypt and Pakistan are seeking to fill the electric-power capacity deficit by utilizing independent power producers in place of nationally owned companies. Their experience shows that, for these arrangements to work, existing legal and regulatory barriers must be overcome and market reforms implemented to encourage private investment. Where reliance on public utilities continues, improved pricing, bill collection, metering and management incentives would help to ensure efficiencies and improve service delivery.

A. Industrial development, growth and poverty eradication

22. While rapidly industrializing developing countries face the challenge of how to manage adverse environmental and social impacts, for most low-income developing countries the principal challenge remains one of setting in motion a

process of self-sustaining growth, with industrial development an important element. Although many developing countries have enjoyed growth accelerations over the past several decades,[8] only a relatively small number have sustained high growth rates over extended periods, China and Viet Nam being prominent recent examples. These countries have achieved significant reductions in poverty rates over the past decade and a half. In China, the population earning a dollar or less per day decreased between 1990 and 2001 from 33 per cent to 17 per cent.

23. Patterns of development differ considerably across countries, as do strategies and policies to promote development.[9] While some countries have followed strategies which give prominence to services and high-value agricultural exports (e.g., India and Chile, respectively), for the rapidly growing economies of East Asia and South-East Asia the development of manufacturing industries for both domestic and export markets has been crucial. In addition to providing an important stimulus to the primary and service sectors, manufacturing offers skilled and semi-skilled employment, stimulates and applies innovation, and tends to be associated with the development of educational systems and modern institutions and legal structures that contribute to socio-economic development.[10]

24. Taking advantage of the opportunities afforded by the international trade system has proven to be an important element of many successful industrial development experiences. Broad export orientation in the rapidly industrializing economies of Asia has generally combined selective and phased import liberalization with export promotion rather than across-the-board trade liberalization. Dynamic exports facilitate learning economies, realization of scale economies in sectors where those matter and financing of capital and intermediate good and technology imports. While electronics and other high-technology exports have been the most dynamic in the past few decades, and developing countries' shares of those exports have been increasing, there are also opportunities for quality upgrading, product diversification and greater domestic processing in medium- and low-technology products, including in natural resource-based industries.

25. In this regard, while there has been substantial multilateral trade liberalization in industrial products, the challenge remains of further lowering tariff and non-tariff barriers to industrial imports and reducing the bias against processed good exports from developing countries caused by tariff escalation. Also important is a strengthened aid-for-trade initiative at the international level to build the capacity of low-income developing countries to respond to new market opportunities, including those that may flow from the Doha Development Round. Services trade liberalization has tended to go faster in areas of special interest to developed countries (telecommunications, finance) than in those of interest to developing countries (labour-intensive services).

26. Political, social and macroeconomic stability are basic features of the domestic enabling environment. Poor basic infrastructure and insufficient human skills and education can constrain industrial development. Building strong state institutions seems to be at the heart of all successful development experience. Weak institutions for market development (e.g., governing contract enforcement and property rights) and a risky investment climate can retard entrepreneurship and private sector development. The binding constraints on industrial and broader economic development can vary over space and time;[11] in some instances, countries may be capital-constrained, while in others the constraint may be low returns on investment.

27. A major challenge facing industrializing countries is the need for continuous upgrading of skills and technological capabilities. In particular, those countries that are specialized in labour-intensive manufactures are vulnerable to production relocation in the absence of skill upgrading and improvement of domestic capabilities to maintain competitiveness vis-à-vis countries with lower labour and other costs. Besides cooperation between private partners along supply chains, public institutions, public-private and academy-industry partnerships and international cooperation can facilitate such upgrading. Government policy can also be important in creating the incentives for entrepreneurial risk-taking to discover new product markets and their associated production costs.[12] In many developing countries, those incentives are weak because of the limited capacity of entrepreneurs to profit from new discoveries, given low entry barriers and rapid imitation. As noted in *World Economic and Social Survey 2005*, "Governments, working closely with the private sector, have an important role in identifying and encouraging the development of new activities in which a country, or a region within a country, may possess a potential comparative advantage".

B. Efficient and cleaner industrial development

28. Countries face a number of interrelated challenges: how to foster more sustainable production processes and patterns of production, how to encourage more sustainable consumption patterns and the widespread adoption of more energy- and resource-efficient products, and how to strengthen the capacity of enterprises to meet new and emerging demands for cleaner, more environmentally sound products.

29. Rapidly industrializing developing countries face the challenge of how to proceed along a sustainable development path. For instance, China's rapid and sustained industrial development is causing serious environmental and social stresses similar to those that the industrialized countries have had to address in the course of their own industrialization. China has elaborated a strategy to mitigate the adverse impacts of industrialization in its eleventh five-year plan for the 2006-2011 period. China and other developing countries pursuing industrialization have an advantage over their predecessors in that, assuming openness to foreign technology and ideas, they should be able to import, as needed, pollution control technologies and know-how and cleaner production technologies that have been developed in other countries. In some cases, new production methods can be both more efficient and cleaner, as for instance in the cement, pulp and paper, and steel industries. While the capital costs may be higher, material, energy and other costs savings can permit relatively short payback periods.

30. In early stages of industrial development, enterprises are often small by world standards, and the most efficient and cleanest technologies may not be cost effective on such a scale. Also, some industries that are important in newly industrializing countries may be stagnant or declining in high-income countries. Therefore, South-South technology and knowledge transfer is of growing importance alongside North-South transfer. The evidence suggests, however, that if such technology transfer is to be promoted, government policies in countries hosting foreign direct investment need to provide the proper incentives for cleaner technology adoption, through a combination of competition policies that foster efficient energy and other input use, environmental policies that foster pollution control at the lowest possible

cost, and technical and financial support to small and medium-scale enterprises to assist them in introducing cleaner production methods.

Box 3
Promoting clean production

In response to Agenda 21, the joint United Nations Industrial Development Organization/United Nations Environment Programme national cleaner production centres programme was set up to promote the widespread application of the cleaner production approach at all decision-making levels in industry. The programme was initiated in eight countries (Brazil, China, Czech Republic, India, Mexico, Slovakia, United Republic of Tanzania and Zimbabwe) in 1995. By the end of 2003, the programme had committed US$ 17.4 million to funding 23 full-fledged centres. Technological changes induced by the programme have generally been relatively simple, requiring modest investment, and frequently involve housekeeping and minor process engineering improvements. Thus, the implemented changes have made only a modest contribution thus far to more sustainable patterns of industrial production. The Marrakech Process on Sustainable Consumption and Production also provides a framework for dialogue, experience-sharing and capacity-building on ways to promote cleaner production methods in industry, as well as on how to assist industries in adapting to stronger consumer preferences for goods that are environmentally benign and produced in ways that promote sustainable development.

Source: Environmental Management Group of the United Nations System.

31. Incentives are important for the adoption of improved environmental management practices and environmentally sound technologies. In high-income countries, such incentives often derive from legislation imposing strict environmental standards, though in recent years innovative approaches have become more common, including the use of economic instruments. In developing countries, a variety of innovative fiscal incentives, mixed regulatory and economic instruments, and information disclosure measures have been introduced. Examples of such policy interventions include: pollution charges (China); compliance-based regulatory enforcement, where waste collection and/or processing is provided free of charge but heavy penalties are imposed for improper waste management (Hong Kong, SAR of China and Thailand); targeted enforcement aimed at major polluters (Brazil); pollutant rating systems involving public disclosure (Indonesia and Philippines). Where local enforcement capacity is weak, pressure from local communities can have an impact in reducing industrial pollution (China, Mexico and Viet Nam). Other approaches include waste minimization demonstration projects with low investment and quick returns (India and Sri Lanka), and the promotion of industrial estates to facilitate inter-company by-product exchange and the use of common treatment facilities (Indonesia, Philippines and Thailand). A variety of policy approaches can address credit market constraints on small and medium enterprises, including the use of grants, loans and loan guarantees for

environmental improvements, and fiscal inducements to the customers of small and medium enterprises to encourage them to transfer cleaner production technologies to their small and medium enterprise suppliers.

32. Hazardous waste management has become a major concern in countries which have been successful in building medium- and high-technology industries that use significant quantities of toxic chemicals and heavy metals. Lack of treatment facilities can result in improper on-site storage of large quantities of hazardous waste, with the risk of spillage or seepage into drinking water supplies, and/or unsafe and possibly illegal disposal of the waste. Malaysia and Thailand have had some success in strengthening hazardous waste management, including through common treatment facilities, while China provides low-interest loans for the construction of such facilities. Many countries have adopted regulations and incentives to promote recovery, recycling and reuse of hazardous materials, e.g., through deposit-refund schemes. Still, collection, treatment and recycling or safe disposal of hazardous waste from multiple small and medium enterprises remains a challenge.

33. Workers in industrial enterprises are generally those most at risk from exposure to toxic substances. In many countries, industrial inspectorates are responsible for ensuring compliance with on-the-job health and safety regulations, but they are often underfunded and understaffed. Penalties for non-compliance may also be weak. Worker training is crucial to fostering a healthy and safe work environment, as are the provision of adequate protective gear, well-functioning environmental-risk monitoring and emergency response systems, and in-plant health and safety committees that include elected workers' representatives and have an effective voice in shaping corporate policies and practices that affect employee health and safety. Examples exist of successful worker-employer cooperation to mitigate adverse environmental impacts of enterprise activities on the communities where they operate and where workers and their families live. Workers and their representatives can also make constructive contributions to addressing the global environmental impacts of firm operations, e.g., through involvement in corporate strategy formulation and implementation for climate change mitigation.

34. Developing country exporters face product-related environmental demands in some of their major developed country markets, e.g., for the phase-out of hazardous substances found in certain industrial products. This is well illustrated by the case of electrical and electronics equipment,[13] where EU legislation implicitly requires that products not contain, or contain less than a given maximum content of, restricted hazardous substances.[14] As the largest developing country exporter in the electrical and electronic equipment market, China is implementing policies to deal with these new requirements together with a number of initiatives targeting domestic safety, quality and environmental standards, including comprehensive legislation regulating hazardous substances and recycling, to be introduced in mid-2006. Other countries with large export-oriented electrical and electronic equipment sectors, notably in East Asia and South-East Asia, will also need to modify product designs and production processes.

35. For domestic enterprises to be able to respond to the quality and reliability requirements and product sanitary and safety standards in major export markets, they require a supporting institutional infrastructure of metrology, testing, certification and quality assurance facilities. As noted at the African regional

implementation meeting for the fourteenth session of the Commission, a continuing challenge is limited government capacity to render and facilitate extension services in these areas, notably for the benefit of small and medium enterprises.[15]

C. Strengthening corporate environmental and social responsibility and accountability

36. Beyond the call of the Johannesburg Plan of Implementation for enhanced environmental and social responsibility and accountability, multinational companies face growing pressures from stakeholders in their home countries to ensure that certain environmental and labour standards are observed in their global operations, including along their supply chains. Some Governments have also responded to these pressures: for example, in 2000, the Government of the United Kingdom of Great Britain and Northern Ireland appointed a minister for corporate responsibility to oversee the Government's role in raising awareness, providing guidance and promoting consensus on national and international codes of practice. Developing country suppliers face the challenge of responding to demands for corporate environmental and social responsibility if they are to remain linked to those supply chains. Multiple customer codes and auditing processes can impose heavy compliance costs on those suppliers, which may also face conflicting pressures from the same customers to contain production costs and meet tight production schedules. Companies in some industries have been working towards greater harmonization of codes and streamlined auditing, while having to be sensitive to anti-trust concerns. In a move towards rationalization, some developing countries have devised their own frameworks for corporate environmental and/or social certification and auditing. China has developed its own "social compliance" standard for the textile industry, while Cambodia has adopted a compliance monitoring system involving both company and workers' representatives in the garment industry. Capacity-building is crucial if such initiatives are to have the intended "race to the top" effect and not to penalize poor countries lacking the capacity to monitor and enforce environmental and social standards, or small firms that lack the capacity to upgrade their own management systems. Also, in competitive industries like clothing, producers have limited capacity to pass on any additional costs to customers.

V. Energy efficiency for enhanced competitiveness, better air quality and climate change mitigation

37. Improving energy efficiency can boost economic performance and industrial competitiveness, while usually reducing emissions of air pollution and greenhouse gases, thereby contributing to industrial development, better air quality and greenhouse gas abatement and thus improving prospects for achieving many goals of the Johannesburg Plan of Implementation and Agenda 21, as well as goals agreed at the 2005 World Summit. Energy provides the process heating, cooling and power needed by industry to create final products from raw materials. Yet, in many instances its use, whether direct or indirect through fossil fuel-generated electricity, results in emissions that pollute the atmosphere. Industrial emissions contribute significantly to ambient levels of particulates, sulphur dioxide and nitrogen oxides (NO_x), especially when factories are located in urban areas. The manufacturing and construction sectors account for about 13 per cent of global CO_2 emissions,

compared with 17 per cent accounted for by the transportation sector. Barriers to reducing air pollution include weak price and other incentives to improve energy efficiency and weak environmental regulations.

38. Evidence shows a decline in global energy intensity of more than 28 per cent during the past decade, with efficiency improving in major industrialized and developing countries. This trend has positive implications for climate change mitigation, since emissions are avoided with improved energy efficiency. The International Energy Agency notes that, without energy intensity reductions in developed countries during the past three decades, energy use would have grown by significantly more than actually recorded.[16] In developed countries, lower energy intensity is the result of improved technology and a structural shift from industry to services. It is notable that major developing countries undergoing rapid economic growth, such as China, have also managed to reduce energy intensity. For some countries, low energy intensity is a sign of lack of industrialization, and thus intensities can be expected to rise in the coming decades before declining. Low energy intensity among industrialized countries, for instance France and Japan, points to rising marginal cost for energy efficiency improvements, as their economies are already operating very efficiently.

Box 4

Energy efficiency potential for reducing greenhouse gas emissions

Opportunities exist for improved energy efficiency in buildings, industry, transportation and the energy sector. It has been estimated that by 2010 most opportunities to reduce emissions will still come from energy efficiency gains in the end-use sectors, switching to natural gas in the electric power sector and reducing the release of greenhouse gases (e.g., perfluoromethane and hydrofluorocarbons) in industrial processes. The table below shows the CO_2 emission reductions that are potentially realizable in 2010 by sector and the range of costs of each. This potential can be realized under appropriate market conditions.

Sector	*Realizable CO_2 reductions*[a]	*Lower cost*[b]	*Higher cost*[b]
Industrial		about 300	
Residential buildings			
Developed countries and countries with economies in transition	325	-250	-150
Developing countries	125	-250	50
Commercial buildings			
Developed countries and countries with economies in transition	185	-400	-250
Developing countries	80	-400	0
Transportation		-200	300
Agriculture		-100	300
Materials management[c]		100	
Fuel switching and technological substitution		-100	200

Sources: IPCC, *Third Assessment Report*, Synthesis Report; and Climate Change 2001: Mitigation (2001).

[a] MtC/y = millions of tons of carbon per year.

[b] In United States dollars per ton of carbon.

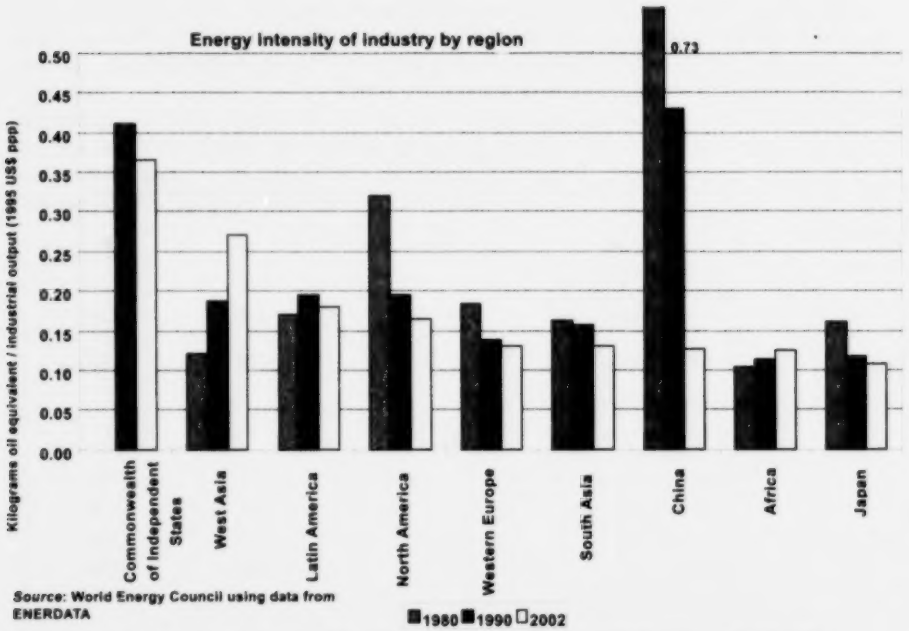
[c] Including recycling and landfill recovery.

A. Energy efficiency in industry

39. Approximately 35 per cent of energy consumed globally is used by the industrial sector and, as globalization and economic reforms have intensified competitive pressures, industrial enterprises have put greater emphasis on efficiency, lowering operating costs, including energy costs, and the costs of doing

business generally. Figure II shows improvements in energy efficiency in industry in many regions since 1980. The potential for energy efficiency improvement in the manufacturing sector has been estimated at up to 25 per cent, with 30 per cent of that improvement due to more efficient motor systems. The manufacturing output of developed countries has doubled since the 1970s, but the amount of energy used in manufacturing has not changed. The intensity of energy use in industry in emerging economies is declining with new investments in the latest production technologies and processes.

Figure II



Source: World Energy Council using data from ENERDATA

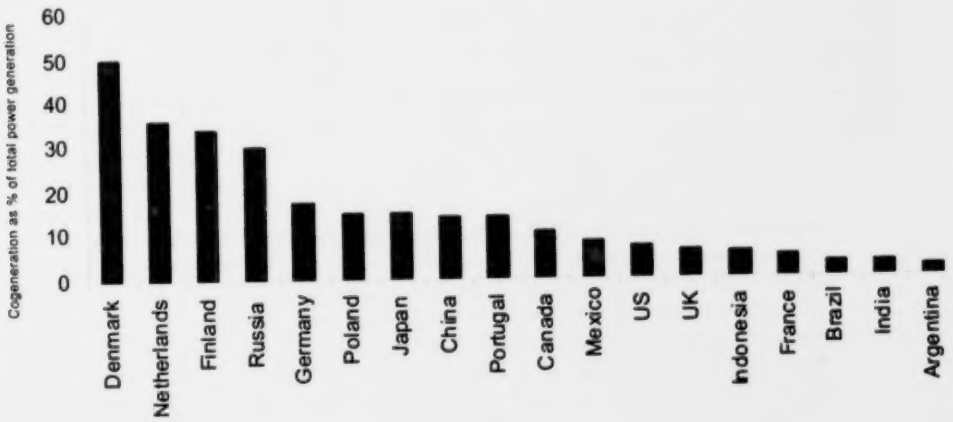
40. Within the same industry there is often wide intercountry variation in energy productivity levels, with the greatest disparities found in such energy-intensive industries as iron and steel, non-ferrous metals, paper and chemicals. Lagging countries are generally catching up with respect to energy-productivity performance, although this process is slow.[17] Within countries there can also be wide variation in energy productivity for plants in a given industry. By one estimate, in Brazil, China, India, Mexico and South Africa, savings in the range of 33 to 49 per cent of the total primary energy used to produce steel are possible, provided that best-practice benchmarks tailored to each country are adopted in all plants.[18]

B. Efficiency in the energy sector

41. The electric power sector is plagued by gross inefficiencies in many countries, and improvements in the efficiency of electricity generation, transmission and distribution can be cost-effective; by one estimate, an average of one third the cost

of capacity expansion per kilowatt-hour (kWh). Worldwide, 65 per cent of the energy used for electricity generation is lost as waste heat. Building new or adapting existing power plants for cogeneration of electricity and heat can reduce that loss to between 20 and 30 per cent. Installed cogeneration capacity in 2004 amounted to 6,926 gigawatts (GW) and has been growing at between 2.5 to 3.0 per cent annually. The share of cogeneration in global electricity generation is just over 7 per cent, despite its enormous potential. The extent of cogeneration in selected countries is shown in figure III. Barriers to more widespread adoption include fluctuations in fuel costs, weak regulations governing power purchase and power transmission, and institutional factors such as monopolies.

Figure III
Extent of cogeneration in selected countries in 2004



Source: *World Survey of Decentralized Energy* 2005, World Alliance for Decentralized Energy, 2005.

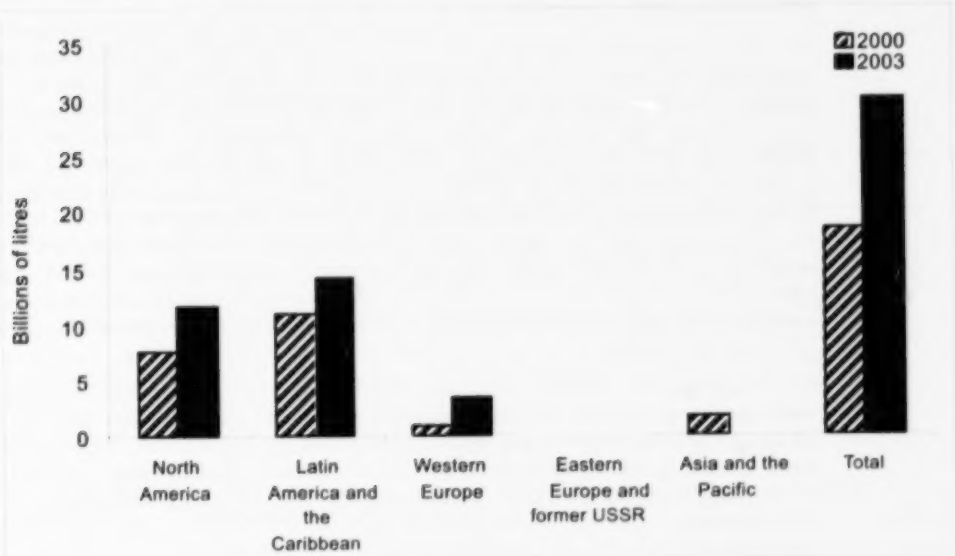
42. The petroleum and gas industry also holds potential for efficiency improvements. Energy costs account for half of petroleum refinery operating costs and competitive benchmarking data indicate that most refineries can improve energy efficiency by between 10 and 20 per cent. Venting and flaring of natural gas still amounts to over 100 billion cubic metres (m^3) per year (about one per cent of global CO_2 emissions), a level unchanged over the past two decades.[19] The current volume of gas flared in Africa could produce 200 terawatt hours of electricity or about half of current continent-wide consumption. Three quarters of global venting and flaring occurs in 10 countries. Barriers to decreasing or eliminating gas flaring include high capital costs, inadequate policy and regulatory frameworks for investments in flaring reductions and lack of gas markets in countries where flaring occurs. The Global Gas Flaring Reduction Partnership led by the World Bank has been working since 2002 to overcome these barriers.

C. Transport sector efficiency potential

43. While there have been achievements in the transport sector since the World Summit on Sustainable Development, this sector continues to pose challenges given its importance as an engine of economic growth and a major employer, as well as a significant energy-consuming sector and source of urban air pollution and greenhouse gas emissions. Transport services remain essential for the competitiveness of a country's industrial sector. (Transport has been selected as an issue for a future Commission on Sustainable Development cycle, when it will be considered in depth.) Higher energy prices in 2004 and 2005 are beginning to have an effect, as sales of more fuel-efficient vehicles and flex-fuel vehicles are increasing in some markets. Should high prices persist, public transport use may also increase over time.

44. The transport sector is the fastest growing energy-consuming sector, with emissions growing accordingly. Since 1990, transport has recorded the fastest sectoral greenhouse gas emission growth in the EU, Japan and the United States. Meanwhile, in many developing countries, rapidly growing vehicle ownership and use reflects improved living standards, while contributing to serious air pollution problems and to greenhouse gas emissions. Some countries have adopted strict vehicle standards and improved fuel quality standards. China currently requires new vehicles to comply with Euro II vehicle standards and has adopted Euro III standards from 2007 and Euro IV standards from 2010 for light vehicles. A regionwide directive by the EU mandates stricter air quality standards, and Sweden, Denmark and Germany are taking measures to avoid fine particle emissions from diesel engines through taxes and the use of fine particle filters. Use of biofuels, including ethanol and biodiesel fuel, has become more widespread, as illustrated in figure IV. In Brazil, flex-fuel cars that utilize both ethanol and gasoline now account for half of all automobiles sold there. Brazil is now exporting cane-derived ethanol production technology to roughly a dozen developing countries. The annual growth in ethanol production in the United States has ranged from 15 to 20 per cent in recent years. Biodiesel production has grown in EU countries, and Indonesia, Malaysia and the United States are initiating production.

Figure IV
World fuel ethanol and biodiesel production by region, 2000-2003



Source: *FO Licht's World Ethanol and Biofuels Reports*, 2003, 2004 and 2005.

45. Public transportation provides an alternative to private vehicle use involving fewer environmental impacts. Successful measures to encourage its wider use include congestion pricing schemes and bus rapid-transit systems, but these require integration into urban planning, with appropriate land-use and zoning regulation. Poor quality of service of public transport systems in some developing countries, including overcrowding and non-dependability of service, is often cited as a constraint discouraging widespread use. Major impediments to improvements are often financial, leading the World Bank to highlight the potential benefits of privatization of government-run systems. Privatization, however, has not always been a smooth ride, even in developed countries; the challenge of adequate investment in and maintenance of infrastructure remains, at least with rail transport.

D. Measures to promote energy efficiency

46. Measures that have been adopted to promote energy efficiency include tax abatement for energy-efficient technologies; benchmarking programmes; standards and labelling programmes; voluntary or negotiated agreements between industry and government; building codes; demand-side management programmes; public-awareness programmes; subsidized energy audits or assessments; and information dissemination tools, such as websites and training courses. Lithuania has successfully upgraded building codes to enhance energy efficiency,[20] Hungary has completed a public-sector energy efficiency programme[21] and Uganda has undertaken public awareness programmes.[22] Tax abatement schemes to promote the

transfer of energy efficient technologies are currently employed in a sizeable number of countries in almost all regions.[23] While energy taxes or energy-related CO_2 taxes can result in reduced emissions, they can also reduce the competitiveness of the taxing country's industry.

47. Promoting energy efficiency through standards and labelling programmes has contributed to meeting the Johannesburg Plan of Implementation goals in 60 countries (see www.clasponline.org). Significant increases in energy efficiency have been realized for electric motors, pumps, compressors, refrigeration, air conditioning, lighting and ventilation. By 2009, it is expected that China will have saved 200 terawatt-hours of electricity (equivalent to all of China's residential electricity consumption in 2002) and avoided emitting 250 megatons of CO_2 due to recently implemented standards. Barriers to developing standards and labelling programmes include the initial investment costs by government and industry for testing facilities, lack of methodological training in technical and economic impact assessments of equipment standards and lack of funding for market surveys to guide labelling development.

48. Hundreds of voluntary and negotiated agreements for energy efficiency improvement or reduction of energy-related greenhouse gas emissions have been concluded between industry and government in at least 18 countries. According to recent results, voluntary agreements have been shown to increase energy efficiency by as much as 50 per cent when adequate incentives for compliance are implemented.

49. The use of energy in the buildings sector, including the use of appliances, equipment and lighting, accounts for 42 per cent of total energy consumption and 36 per cent of total energy-related CO_2 emissions.[24] Since the scope for energy savings is significant, many countries and local authorities have developed energy efficient building codes to guide design and construction. So-called green buildings have been shown to consume a fraction of the energy requirements of typical commercial structures.

VI. Cleaner energy technologies for reducing air pollution and greenhouse gas emissions

50. The development and widespread adoption of cleaner energy technologies, including cleaner thermal power technologies, will help reduce air pollution and greenhouse gas emissions and advance sustainable development in both developed and developing countries. Such technologies often provide win-win solutions since many are associated with higher efficiency and/or less expensive energy inputs, as with many renewable energy technologies. Incremental progress across the broad spectrum of cleaner energy technologies has resulted from intense research and development activities in response to environmental and economic concerns. Many of these technologies are now commercial, but the development of advanced and cleaner versions of some are still many years away from commercialization and needs to be accelerated. Moreover, for large capital-intensive power plants designed to operate for many decades, the phasing-in of plants using advanced, cleaner technologies will extend over a similar period. The costs of new energy technologies are often high, however, in their early adoption phase, since research and

development expenses and associated capital costs must be covered, which poses a constraint for developing countries.

A. Renewable energy technologies

51. From 2000 to 2003, significant expansion occurred in the use of non-hydro renewable energy for power generation in all regions, as shown in table 2. Still, the contribution of these sources to total energy supply remains quite small. Increases noted in North America and Western Europe during this period are partly due to measures and regulations, including feed-in tariffs and specific renewable energy targets set at the national level. Considerable efforts are still required to meet the Johannesburg Plan of Implementation goal of substantially increasing the global share of renewable energy sources in the total energy supply. Conferences on renewable energy held in Bonn in 2004 and in Beijing in 2005 have stimulated cooperation in working towards this goal. In 2002, all renewable forms of energy, including large hydropower and non-commercial biomass, were estimated to provide only 13.4 per cent of the global primary energy supply, with 2.2 per cent from hydropower of all sizes, 10.8 per cent from combustible biomass and 0.5 per cent from geothermal, solar, tidal and wind energy. The annual growth rates of the energy generation capacities for selected renewable energy sources averaged over the period 2000-2004 are shown in table 3. Notwithstanding some increased use of renewable energy sources in developing countries, most notably in China and India, the main markets for non-hydropower renewable energy have been in developed countries, which accounted for 92 per cent of the market share of wind power and 88 per cent of photovoltaic cell production in 2003. Many developing countries lack the legal and regulatory frameworks to attract investment and private sector involvement. Relatively high capital costs also continue to deter more widespread applications.

Table 2
Renewable energy from world geothermal, solar, wind, and wood and waste for electric power consumption by region for 2000 and 2003

(Billion kilowatt-hours)

Region	*2000*	*2003*
North America	93.3	102.1
Latin America and the Caribbean	23.5	31.9
Western Europe	75.0	110.4
Eastern Europe and countries of the former USSR	3.8	4.7
West Asia	0.003	0.01
Africa	0.9	1.01
Asia and the Pacific	53.0	60.0
Total	**249.5**	**310.1**

Source: Energy Information Administration, United States Department of Energy, June 2005, arranged according to regions of the United Nations; see www.eia.doe.gov.

Table 3
Existing global capacities in 2004 and average annual growth rates from 2000 to 2004 for energy from selected renewable sources

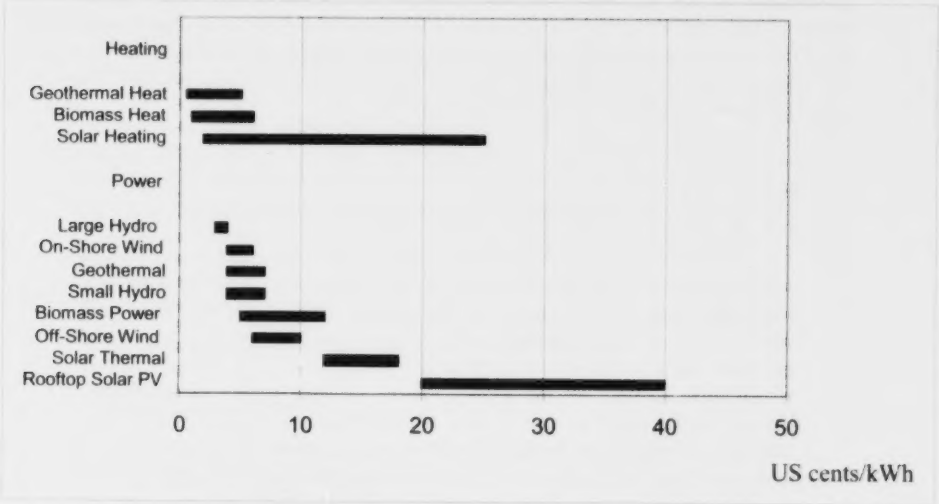
Source	*Capacity at end of 2004*	*Average annual growth rate 2000-2004 (per cent)*
Hydropower	801 GW	2.5
Wind	48 GW	29
Solar photovoltaic	4 GW	29
Geothermal	36.9 GW	10
Liquid biofuels	33.2 billion litres	11

Source: The Worldwatch Institute, *Renewables 2005: Global Status Report* (2005).
Note: Geothermal covers electricity and heat generation.

52. While the cost of producing energy from renewable sources varies considerably by source (as shown in figure V), relative prices of electricity per kWh from renewable sources remain high, especially where conventional fuels are subsidized. Given that the cost of producing conventional electricity ranges between US$ 0.02-0.05/kWh, renewable energy is not cost competitive in many areas and this has curbed market growth. Under suitable conditions, however, with optimized system design, siting and resource availability, modern biomass, small hydropower, wind and geothermal plants can produce electricity in this cost range.

53. Considerable national and international efforts to promote renewable energy have been made, including those under the recently culminated World Solar Programme 1996-2005 (see A/60/154). At least 45 countries worldwide have adopted specific targets for the portion of renewable energy in the overall energy mix. A number of countries, including Brazil, China, India and the Philippines, have instituted major programmes and arrangements for renewable energy development. However, in most other developing countries, programmes are still too small to have a significant impact on their national energy systems, due largely to lack of access to affordable renewable energy technologies. A number of voluntary actions and pledges have followed the 2004 International Conference for Renewable Energies in Bonn, and the Beijing International Renewable Energy Conference in 2005, which, if implemented, would avert sizeable CO_2 emissions.

Figure V
Cost ranges for heating and grid power using selected renewable energy technologies



Source: The Worldwatch Institute, *Renewables 2005: Global Status Report* (2005); International Energy Agency, *Renewables for Power Generation* (2003).

Note: Costs include capital costs based on a discount rate of 6 per cent and an amortization period of 15 to 25 years. Lowest cost range refers to optimum conditions of proven technology, optimized plant size and design, and high availability of system and resources.

54. Hydroelectricity plants produce zero emissions if the reservoir is cleared of vegetation prior to filling. However, large plants may interfere with land use, disrupt local ecology and force the displacement of the local population. Run-of-the-river and mini-hydropower plants have fewer impacts, but are suitable for small-scale loads only. Large hydropower resources are utilized extensively, but plant capacity has been expanding slowly. After initial capital expenses for construction, operating costs are generally modest. Africa has untapped hydropower potential, and many African Governments have expressed interest in pursuing this option to improve energy access and to spur industrial development. A 2004 meeting of Governments, international organizations, industry and professional associations, and non-governmental organizations (NGOs) in Beijing noted that two thirds of economically viable hydropower potential has yet to be tapped, with 90 per cent of that potential in developing countries, and called for the dissemination of good practices, policies, frameworks and guidelines for hydropower development that is sustainable.[25]

55. Success with wind power in Denmark, Germany and Spain has been promoted by feed-in tariff systems, which offer attractive buy-back rates and guarantee a market for wind-farm output. This has enabled a growing export capability in wind technology and equipment, most notably in Denmark and Germany. When completed in 2006, a wind farm in Estonia will provide electricity to the national grid while reducing annual CO_2 emissions by 400,000 tons. Challenges associated

with further wind energy development include technical limitations, restrictions on land use, aesthetic concerns and wildlife safety.

56. The total installed capacity worldwide for electricity production using geothermal energy has increased from 8,000 MW in 2000 to 8,900 MW in 2003, or about 10 per cent. Potential for developing geothermal resources is significant along the Rift Valley in East Africa. Major barriers to developing geothermal resources are the high upfront investment costs, the difficulty of assessing the resource prior to investment and inadequate local technical skills.

Box 5
Implementation of the World Solar Programme 1996-2005

The World Solar Programme 1996-2005 has made a significant contribution to raising awareness of the increased role that new and renewable sources can play in the global energy supply. New and renewable sources of energy have begun entering the mainstream of national and international energy-policy formulation and now constitute an integral element of the global vision for sustainable development. Under the auspices of the United Nations Educational, Scientific and Cultural Organization-initiated programme, a considerable number of developed and developing countries have implemented local and national projects using energy from renewable sources. National programmes have included assessment studies of renewable energy potential, large- and small-scale investment in electricity generation, and national institution-building, capacity-building, advocacy and public information initiatives. While the initial plan of the programme was quite ambitious, the number of projects eventually funded did not meet early expectations.

Source: A/60/154.

B. Advanced fossil fuel technologies

57. New technologies for coal-fired power-generating plants are being utilized to control emissions, to improve coal combustion and to convert coal to a cleaner fuel. For instance, supercritical pulverized combustion[26] plants, of which there are currently about 400 in operation, can achieve efficiencies of 45 per cent, as compared to an average of 36 per cent for coal-fired power plants in developed countries and 30 per cent in developing countries. China has adopted this technology for new construction. Currently, South Africa is the largest producer of synfuels[27] produced by the gasification of about 40 million tons of coal annually.

58. Switching from coal or oil to natural gas significantly reduces greenhouse gas emissions, and technological advances have made natural gas a convenient fuel both for power generation using advanced high-speed gas turbines and for transportation. Moreover, progress is being made in finding a more economical process for converting natural gas to a liquid fuel, and liquefaction is currently used by several companies, principally Sasol, of South Africa. This process is the basis for the 9,300 m^3/day natural gas-to-liquid fuel complex under construction in Qatar and a

similar complex in Nigeria, using gas that would otherwise have contributed greenhouse gas emissions through flaring. This is a promising technology available for other South-South joint ventures.

Box 6

Pollution control technology for coal-fired power plants

Nearly every coal-fired power plant in the United States and most in other countries of the Organization for Economic Cooperation and Development (OECD) use advanced pollution control technology, unless the plant was initially designed to use advanced clean coal technology. Currently, the deployment of any of these technologies is quite limited in developing countries, primarily due to the high capital and operating costs. Since there are only 15 major coal-consuming non-OECD countries, significant reductions in current and future air pollution and, to a lesser extent, CO_2 emissions could be achieved by facilitating a transfer of advanced, clean coal technologies to these few countries.

59. Among potentially significant technologies for mitigating greenhouse gas emissions is CO_2 capture and storage, for which significant technological advances are being made. Capture and storage involves CO_2 separation from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere. This technology is particularly relevant for large point sources, including fossil fuel or biomass energy facilities, major CO_2 emitting industries and natural gas production and synthetic fuel plants. It is estimated that more than 60 per cent of CO_2 emissions are from stationary sources; however, not all of these would be amenable to capture and storage.[28] Research in several countries is exploring the prospects for storage in geological formations, in the ocean and in mineral carbonates, as well as for use in industrial processes. A number of countries, including Algeria, Canada, the Netherlands and Norway, have applied CO_2 capture and sequestration technology. Developed and developing countries that account for approximately three quarters of all anthropogenic CO_2 emissions have formed the Carbon Sequestration Leadership Forum to promote cooperative research and development into capture and storage as a contribution to achieving the United Nations Framework Convention on Climate Change goal of stabilizing the atmospheric CO_2 concentration. Following the publication of the special report of the Intergovernmental Panel on Climate Change on capture and storage, the Subsidiary Body for Scientific and Technological Advice has recently been tasked by the Conference of the Parties to the United Nations Framework Convention on Climate Change to explore technical aspects of applying this technology to mitigating CO_2 emissions.

C. Other advanced energy technologies

60. Government concerns for energy security, industrial development, climate change and atmospheric pollution have led to renewed interest and some expansion in the use of nuclear energy. A total of 442 nuclear power plants are now in operation, 19 of which were commissioned after 2000. A number of nuclear reactor

concepts have been developed that attempt to address public concerns about the safety and proliferation risk of nuclear power. Some of these are of modular design and could improve the economics of medium- and small-scale reactors. Nevertheless, public apprehensions about the safety, proliferation, terror risks and waste disposal of nuclear reactors continue to restrain expansion of this energy source.

61. The fuel cell is an emerging technology under intense research that is just beginning to be commercialized. Although not yet economical for most applications, fuel cells can provide electricity on a small or large scale and can power vehicles using gasoline, other hydrocarbon fuels or hydrogen. Most fuel-cell vehicles currently in operation are cars and buses for testing, demonstration and trial.

62. Hydrogen could be a key component in a clean, sustainable energy system popularly referred to as the "hydrogen economy", a focus of much research. The system features hydrogen as the major energy carrier for stationary power, transportation, industry, residences and commerce. However, for such a system to be environmentally friendly, the primary energy source would have to be renewable. So far, the systems for producing hydrogen consume too much energy and are too costly. Iceland is attempting to establish such an economy with hydrogen produced, using its relatively abundant sources of hydropower and geothermal energy.

63. Resources devoted to research and development of advanced, cleaner energy technologies and for technology transfer are still modest. The small group of industrialized countries that fund most of the global research and development on energy are defining the world's future energy technology choices. As with all research, a major obstacle to achieving research and development breakthroughs is financial, and ensuring that means of implementation, including financial mechanisms, are in place is crucial for achieving Agenda 21 and Johannesburg Plan of Implementation "energy for sustainable development" goals.

VII. Meeting financing needs for energy, industrial development and emissions reduction

64. Several trends have been positive for financing energy and industrial projects, sometimes associated with privatization trends. Emerging markets have been able to attract increasing amounts of capital through bond markets, equity markets, loans and direct investments partly because developing countries are improving the management of liabilities and minimizing debt costs and financing risks. Private net capital flows to developing countries totalled almost US$ 325 billion in 2004, up from US$ 200 billion annually in the 2000-2002 period.[29] This represents a return to the high levels achieved in the 1996-1997 period. Sources of funds have also broadened somewhat, with institutional investors such as pension funds now investing US$ 7.3 billion in emerging markets. Foreign direct investment flows to developing countries increased in 2004 by 40 per cent over 2003 levels, reaching an estimated US$ 233 billion, or 36 per cent of global foreign direct investment flows.[30] Such flows, however, remain strongly directed to a few countries. Foreign direct investment flows are expected to continue to increase, with a significant portion destined for the oil, gas and power sectors. Those flows have to some extent offset the decline in official development assistance in the 1990s and, although a turnaround in official development assistance has occurred recently, levels are still

low in relation to recipient countries' gross domestic products (GDP) and only a small fraction — less than 5 per cent — is directed to energy projects.

65. The bulk of financing for industrial development will have to come from private sources. Thus, creating enabling policies and institutions for domestic entrepreneurship, productive investment and bank lending to industrial enterprises, including small and medium enterprises, are critical (see section IV).

A. Stimulating investment in energy infrastructure and services

66. A central element of any reform is the separation of the different state functions in the energy sector, particularly the separation of planning from regulation and management of state enterprises (when the latter is still relevant). Some countries have been able to attract private sector investment through privatization. Others have reformed state enterprises to improve efficiency, or have engaged in public-private partnerships of different sorts. These reflect the diverse strategies followed by different countries aimed at improving efficiency and increasing access.[31] By 2000, of 115 developing countries, 33 per cent had passed new electricity laws, 29 per cent had established an independent regulator and 40 per cent had allowed the participation of privately owned independent power producers.

67. Electricity projects with private sector participation have attracted substantially increased investments in recent years, particularly in Asia. In 2003, 19 developing countries implemented 36 new electricity projects with private participation, ranging from management contracts (Rwanda) and concessions (Cameroon) to partial divestitures (China) and greenfield build-operate-transfer and build-operate-own projects (Angola, Malaysia, Nigeria, the Philippines, Thailand and Viet Nam).[32] While still significantly below the 1997 pre-Asian-crisis peak, investment flows to the electricity sector have increased in the past few years. In 2003, the overwhelming share of foreign power sector investment went into stand-alone power plants or to independent power producers, with a much smaller share going to distribution companies.

68. Important though foreign capital may be, domestic resource mobilization is crucial to financing energy and industry investments. Thus, banking sectors and financial markets in many developing countries need further widening and deepening to tap domestic savings. In Asia, bank lending now amounts to around 50 per cent of GDP. In many African countries, however, investment needs relative to domestic savings are high. Domestic banks in many developing countries tend to be small and incapable of lending for large-scale energy projects. In this context, national or regional development banks may still have an important function. Constraints to strengthening local capital and bond markets include lack of transparency and regulations that add to the already high cost of issuing bonds, as well as the absence of transparent secondary markets that would improve liquidity.

69. Recent estimates by the International Energy Agency indicate that significant levels of investment are required to meet growing energy demand.[33] Meeting energy-financing needs of sub-Saharan Africa remains a particular challenge, and investment needed in the energy sector alone to achieve the Millennium Development Goals has been estimated at US$ 14.3 billion annually to 2015.[34]

Investment amounts required by region and by energy type are shown in tables 4 and 5, respectively.

Table 4
Required energy investment by region, 2001-2030
(Billions of constant 2000 United States dollars)

Region	*Energy investment*
Developed country regions	
North America	3 488
Europe (OECD)	2 064
Pacific (OECD)	1 000
Countries with economies in transition	1 672
Developing country regions	
Africa	1 208
Asia and the Pacific	4 308
West Asia	1 044
Latin America and the Caribbean	1 337
Total	**16 481**

Source: International Energy Agency, *World Energy Investment Outlook* (2003).
Note: Total includes interregional transportation.

Table 5
Required world energy investments by energy type, 2001-2030
(Billions of constant 2000 United States dollars)

Energy type	*Energy investment*
Oil	3 096
Gas	3 145
Coal	398
Electricity	9 841
Total	**16 480**
Annual average	549

Source: International Energy Agency, *World Investment Outlook 2003* (2003).

70. Meeting infrastructure financing needs for sustainable development has been given renewed attention by multilateral institutions since the World Summit on Sustainable Development. The World Bank has implemented significant increases in its infrastructure lending. Its energy project lending increased from US$ 1.4 billion in 1999 to US$ 1.9 billion in 2005, largely with a view to improving energy access. Its recent investment of US$ 450 million in the Southern African Power Market project is expected to increase the availability and reliability of low-cost, environmentally friendly energy services. By ensuring that power systems are

developed cooperatively rather than individually, the project could save the region more than US$ 1 billion over 16 years. Another innovative example is the EU work on developing a patient capital fund, or "fund of funds", to direct private investment to renewable energy projects, including those to improve access to energy. A long-standing working example of South-South cooperation, the Organization of Petroleum Exporting Countries (OPEC) Fund has disbursed a total of US$ 5.2 billion to 96 countries since its inception for a range of measures including poverty eradication, science and technology, energy and renewable energy.

71. The fundamental challenge of financing energy access in many developing countries is that entrenched poverty and very low income levels inhibit the ability of consumers to pay for energy services. In developing countries with low incomes, especially those in remote areas characterized by low population densities, consumers may be unable to pay fees to cover the capital costs of extending services. Targeted use of subsidies to ease the burden of up-front costs together with cross subsidization schemes and end-user fees reflecting a realistic view of ability to pay can result in a successful long-term effort to improve access to energy. Utilizing local entrepreneurs or cooperative arrangements for operation and maintenance can be effective when accountability is assured. As noted above, innovative financing arrangements and other measures to promote energy access can significantly contribute to poverty alleviation.

72. One financing model that addresses the situation of the poor is microfinance, pioneered by Grameen Bank in Bangladesh, which provides small loans for productive enterprises and craft cottage industries, including in the informal sector. Providing loan guarantees to small and microenterprises has been undertaken in a number of countries to secure domestic financing for local infrastructure projects, the bankability of which can be improved by coupling with capacity-building projects. In some cases, donors guaranteed loan portfolios rather than provide funding. This innovative approach has met with success in Bangladesh, Bulgaria, Egypt, Georgia, Kazakhstan, the Philippines and South Africa with funding from the United States. A microcredit scheme launched in Nepal for farmers wanting to install biogas plants has benefited 3,000 people.[35] South Africa is financing its improved access to electricity in urban areas with prepaid billing cards, but is seeking other solutions to provide energy for those unable to pay and to finance decentralized energy systems in rural areas.

73. Overcoming barriers and constraints to resource mobilization entails ensuring an enabling environment, utilizing risk-pooling and -sharing techniques and minimizing lending risks. Inadequate understanding of financial mechanisms and knowledge of and ability to tap into available financial resources are also obstacles. Improved subregional, regional and international cooperation can play an important role in improving financing for sustainable development with a focus on strategic investments with high social returns.

B. Funding climate change mitigation and adaptation

74. Funding climate change mitigation is important for achieving sustainable development. Since 1994, significant investment in core mitigation activities and sectors in developing countries has occurred. An examination of trends in mitigation investment suggests that financial flows from the private sector dominate the core

mitigation investments in developing countries, followed by investments through official development assistance.[36] These investments are largely devoted to energy efficiency, industry and transport projects, and hydroelectricity plants, though some other renewable energy projects have also been undertaken. However, underfunding of adaptation is still a barrier to achieving Agenda 21 and Johannesburg Plan of Implementation goals.

Box 7
Clean Development Mechanism

One of the key elements of the Kyoto Protocol of the United Nations Framework Convention on Climate Change, implementation of the Clean Development Mechanism accelerated in 2005, which is set to continue in 2006. Ensuring a strong Clean Development Mechanism with streamlined and simplified procedures remains a high priority for the parties.

The first Clean Development Mechanism project was registered in November 2004, and a total of 70 projects had been registered by mid-January 2006. These projects are expected to generate some 200 million tons of certified emission reductions.[37] By that time, more than 550 projects had entered the pipeline in the areas of renewable energy (57 per cent of projects and 18 per cent of certified emission reductions), energy efficiency (14 per cent of projects and 5 per cent of certified emission reductions), fuel switching (4 per cent of projects and 1 per cent of certified emission reductions), methane emission reduction and cement production efficiency improvements (23 per cent of projects and 24 per cent of certified emission reductions), and hydrofluorocarbon and nitrous oxide emission reduction (2 per cent of projects and 52 per cent of certified emission reductions). Reforestation and afforestation are new areas where projects are being developed. Therefore, a significant supply of certified emission reductions can be expected in the future to help meet the demand for credits from the parties and companies that have to comply with their targets. More than half of the projects are in the Asia and the Pacific region and nearly 40 per cent are in the Latin America and Caribbean region, but only 2.5 per cent are in Africa. Assisting developing countries, particularly in sub-Saharan Africa to develop capacities for their active participation in the Clean Development Mechanism is an urgent priority. Projects vary greatly in size, with more than half of small size at or near the community level and a few large ones that reduce industrial emissions and generate the bulk of certified emission reductions. The parties to the Kyoto Protocol have explicitly recognized the need to ensure continuation of the Clean Development Mechanism beyond 2012.

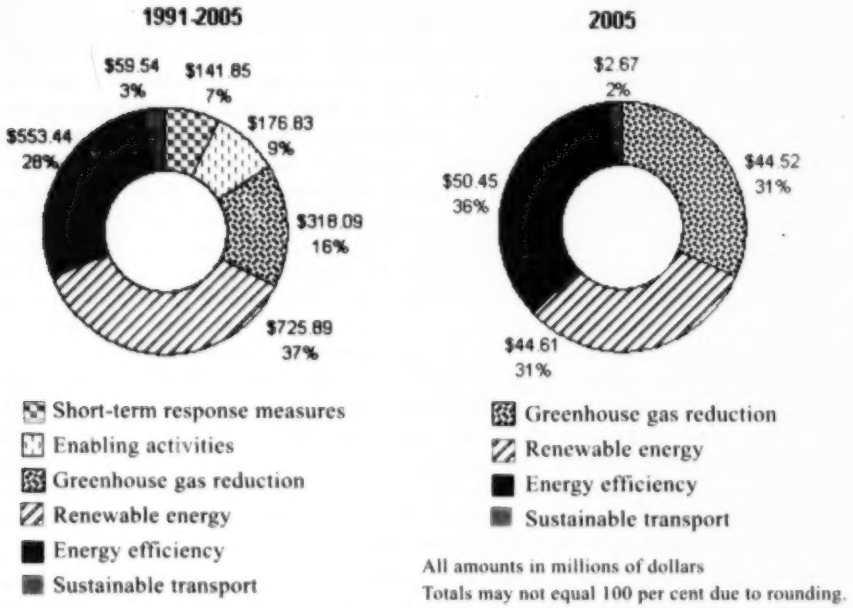
Source: Adapted from data provided by the United Nations Framework Convention on Climate Change secretariat.

75. Further means of implementation are needed to cope with the results of the increasing frequency of floods, droughts and other extreme weather events, some of

which is attributable to human-induced climate change. Adaptation has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all negative impacts. Since the World Summit on Sustainable Development, the parties to the United Nations Framework Convention on Climate Change have directed the Global Environment Facility to support adaptation efforts in developing countries, particularly in least developed countries and small island developing States. New funds established as a result of the decision of the Conference of the Parties to support such activities through the Global Environment Facility have strengthened the prominence of adaptation activities in Global Environment Facility operations. As a result, there are currently four Global Environment Facility avenues available to fund projects aimed at enhancing adaptive capacities of developing countries: the Least Developed Country Fund, the Special Climate Change Fund, the Adaptation Fund and the Strategic Priority on Adaptation, under the Global Environment Facility Trust Fund. The detailed programme priorities of the Adaptation Fund remain to be decided. The multilateral development banks have invested sizeable amounts in adaptation-relevant projects, mostly in the water and agriculture sectors. With initial donor pledges of US$ 34 million as of November 2005, the Special Climate Change Fund will provide resources for adaptation, technology transfer and associated capacity-building. As of November 2005, the initial voluntary contributions to the Least Developed Country Fund, established to support the preparation of national adaptation programmes of action in least developed countries, amounted to US$ 32.9 million.[38] However, stepped up contributions to the funds established under the Convention and the Protocol are essential.

76. As the financial mechanism of the United Nations Framework Convention on Climate Change, Global Environment Facility resources are directed towards improving energy efficiency, promoting renewable energies, reducing the cost of low greenhouse gas-emitting-energy technologies, and supporting sustainable transport. In 14 years, the Global Environment Facility clean energy/climate change portfolio has grown to more than US$ 1.9 billion in grants for projects with a total value of nearly US$ 12 billion, as shown in figure VI. Nevertheless, developing countries have expressed concerns about the lengthy procedures for approval of projects and the disbursal of allocated funds.

Figure VI
Global Environment Facility portfolio investments in climate change



Source: Global Environment Facility secretariat, *Global Environment Facility Global Action on Climate Change* (2005).

77. The entry into force of the Kyoto Protocol to the United Nations Framework Convention on Climate Change on 16 February 2005 has strengthened the carbon market, with more countries adopting national emissions trading programmes in preparation for active engagement. A strengthened global market could provide a unique opportunity not only to mitigate greenhouse gas emissions, but also to generate global efficiency gains and contribute to sustainable development. The three flexibility mechanisms introduced by the Kyoto Protocol — the Clean Development Mechanism, Joint Implementation and Emissions Trading — constitute the building blocks of the international carbon market.

78. A key challenge facing the carbon market is to retain the validity of carbon credits generated by the flexibility mechanisms under the Kyoto Protocol beyond 2012. Uncertainties exist that create a barrier to active participation by the private sector in the global carbon market, but they could be overcome with stronger price signals for emissions reduction credits beyond 2012. The private sector notes that "regarding impacts, businesses are also committed to reduce pollution, emissions, and to tackle climate change, but they cannot do it through isolated actions. To enable widespread action, it is essential that Governments agree on realistic and quantifiable long-term objectives upon which industrial strategies and technology choices will be built."[39] An open-ended group to initiate negotiations on commitments of Annex I Parties[40] to the United Nations Framework Convention on Climate Change for the period beyond 2012 has been established. Moreover, all

countries have accepted to be part of a parallel process launched under the United Nations Framework Convention on Climate Change, which aims at exchanging experiences and information on "long-term cooperative action" to address climate change.

79. In anticipation of having to meet the commitments of its member States under the Kyoto Protocol, the EU adopted an internal emissions trading scheme in 2004, which began a two-year pilot phase in January 2005. EU member States have set limits on CO_2 emissions from about 12,000 energy-intensive companies by issuing allowances that determine how much CO_2 each company is allowed to emit. Companies that can reduce emissions at low cost have the incentive to sell excess credits in the market, thereby ensuring that reductions are made at the lowest possible cost to the economy and that innovation is promoted. EU members trade EU allowances on a European-wide market. It is estimated that the companies currently participating in the scheme account for around 45 per cent of total CO_2 emissions in the EU. The EU has also decided to allow trading of EU allowances with mechanisms of the Kyoto Protocol, including the Clean Development Mechanisms and Joint Implementation, under certain conditions.

VIII. Subregional, regional and international cooperation

A. Energy security

80. Energy security concerns arise from differences in patterns of energy consumption and energy production among countries and regions and are allayed in part by extensive and reliable trade in energy resources and services. Regional variations in commercial energy consumption and production illustrate these differences. The greatest increases in energy consumption during the period 1990-2003 were in developing countries in Asia. Annual average increases of 10 per cent or more were recorded in West Asia and Asia and the Pacific, while North American and European energy consumption increased on an annual basis by only 3 per cent and 5 per cent, respectively. Annual energy consumption in Africa grew by 5 per cent during this period. However, in absolute terms North America remains the largest energy-consuming region. Production of commercial energy also varies considerably by region, as do fossil fuel reserves and other energy resource endowments.

81. Concerns over energy security have been heightened with the recent significant increase in energy prices. A number of factors, including strong global economic growth, the consequent rise in demand for oil and a reduction of spare capacity, combined with constraints in the downstream sector, geopolitical developments and increased activity in oil futures markets, have contributed to higher oil prices during the past two years. This has resulted in a renewed focus on energy diversification and efficiency, both of which are addressed in the Johannesburg Plan of Implementation. Higher oil and gas prices strengthen incentives to improve energy efficiency, contribute to making other energy sources more competitive and stimulate research and development in biofuels and advanced energy technologies, particularly in the transport sector. Moreover, previously unexploited oil resources are being tapped, including tar sands. Addressing the world's growing demand for energy resources and ensuring the reliability of global

energy supplies on a fair and stabilized energy market calls for comprehensive and integrated policies that consider both demand and supply aspects, as indicated in the Johannesburg Plan of Implementation, as well as cooperation by all countries.

82. A reliable energy supply will require increased investments in and support for upstream and downstream infrastructures, including oil-producing infrastructures. Export-dependent energy producers face the challenge that instability in energy prices complicates macroeconomic management and can undermine long-term growth. They also face the challenge of diversification to reduce dependency on oil and gas exports.

83. Many countries have underlined the importance of security of supply and market transparency, as well as the need to cooperate and to encourage greater energy investment. Significant investments in cross-border trade in energy, including pipelines and electricity interconnections, have allayed some of these concerns. Regional integration can contribute to improved energy security, as demonstrated by recent projects in Africa, including the Southern Africa Power Pool project, the West Africa Power Pool project and the West Africa Gas Pipeline project, as well as the gas pipeline from Mozambique to South Africa. The recent rise in oil prices has lent urgency to calls for improving information and transparency, including through the Joint Oil Data Initiative. Some countries are also seeking greater diversification to lessen dependence on any single energy source or any single energy supplier.

84. Regional and international institutions can play a potentially significant role in ensuring energy security. Enhanced dialogue and collaborative action among players, including between producers and consumers, needs to be encouraged. The United Nations plays an active role in such initiatives as the Special Programme for the Economies of Central Asia, and by actively participating in the Joint Oil Data Initiative. Topical conferences such as the International Energy Forum have also been effective.

B. Subregional and regional cooperation

85. While cooperation since the World Summit on Sustainable Development on energy, industrial development, air pollution/atmosphere and climate change at the subregional, regional and international levels has improved, sustainable development achievements have only begun to be realized. A number of regional institutions to provide better focus and coordination on activities have been put in place or strengthened in Africa, but cooperation among institutions remains a challenge. The recent establishment of the Forum of Energy Ministers of Africa may assist in overcoming some of these challenges. Cooperation is already taking place under the auspices of the New Partnership for Africa's Development, with the support of the United Nations. The World Bank's Clean Air Initiative for Africa cooperates with regional institutions and partnerships, including the World Summit on Sustainable Development Partnership for Clean Fuels and Vehicles, in successfully eliminating lead from gasoline in Africa. The private sector has also encouraged better cooperation in Africa through such associations as the World Energy Council.

86. The Clean Air Initiative for Asian Cities, initiated in 2002 by the World Bank and the Asian Development Bank, has created a network of national and regional

institutions to address urban air pollution in Asia. The Asia Alternative Energy Programme of the World Bank has been active since the early 1990s in providing advice, assessing projects and identifying potential activities. The Asia-Pacific Economic Cooperation (APEC) forum has a voluntary energy working group to facilitate energy trade and investment. A priority of APEC is expanding natural gas trade, including liquefied natural gas.

Box 8

Convention on Long-range Transboundary Air Pollution: a model for reducing transboundary air pollution

The Economic Commission for Europe Convention on Long-range Transboundary Air Pollution has tackled the problem of acidification in Europe with success. The original 34 countries that signed the Convention, which entered into force in 1983, have been joined by 16 others, bringing the current participants to 50 nations. The successful Convention has an innovative approach that relies on scientific expertise and easy replicability: besides establishing the general principles of international cooperation for air pollution abatement, it sets up an institutional framework for bringing together research and policy formulation. Sulphur emissions have been cut by about 60 per cent since 1980 and, to a lesser extent, emissions of NO_x and volatile organic compounds have decreased. As a result, acidification of the soils and waters in Europe and North America, the problem that prompted countries to sign the Convention, is now declining. (See forthcoming report "Trends in sustainable development".)

Source: EMEP Assessment Report (2004).

87. In West Asia, the Organization of Arab Petroleum Exporting Countries provides a venue for cooperation on a wide variety of energy-related activities and the Arab Fund for Social and Economic Development funds energy projects, including regional electricity interconnections. The regional implementation meeting for the fourteenth session of the Commission on Sustainable Development,[41] held in Cairo, noted that the average electrification rate for the Arab countries is 70 per cent, domestic energy prices are subsidized and improvements in energy efficiency have been made. It highlighted the potential for greater cooperation on energy, including electricity interconnection and natural gas networks, as well as on climate change control and mitigation and information-sharing on a range of issues, including industrial environmental management.[42] The Latin American Energy Organization facilitates regional cooperation on energy policies and projects and disseminates information and data.

88. In addition to the need to overcome barriers to energy efficiency improvements, security of energy supply was identified at the regional implementation forum of the Economic Commission for Europe to be of particular concern, and challenges include diversifying both geographical and fuel sources, securing adequate investment in production, transport and distribution infrastructure and strengthening dialogue between producer and consumer countries.[43] The Asia-

Pacific regional implementation meeting noted that the current pattern of economic growth presents challenges to sustainable development and major threats to environmental stability in the Asia-Pacific region, and that a focus on stimulating investment in markets for environmentally sustainable goods and services would provide business opportunities and employment, as well as increase environmental protection.[44]

C. International cooperation

89. In connection with international conventions, systematic monitoring of various air pollutants and greenhouse gases is necessary to support assessments of the state of the atmosphere and the stability of the climate system. This requires that data be collected both by local surface stations and satellites. Among initiatives to monitor the atmosphere is the Integrated Global Observing Strategy, a consortium of 13 international organizations that integrates satellite, airborne and local atmospheric observation systems. The Strategy has a number of programmes and initiatives to support the development of a comprehensive, coordinated and sustained Earth observation system and the implementation of the Global Earth Observation System of Systems. Currently, it has 61 participating countries and nearly 40 international organizations. In addition, the World Meteorological Organization operates Global Atmosphere Watch to improve understanding of atmospheric change and to provide data for information and policymaking.

90. International cooperation has been strengthened by the formation of World Summit on Sustainable Development partnerships. Many have garnered support from local and/or regional organizations and recently some, such as the Global Village Energy Partnership, the Renewable Energy and Energy Efficiency Partnership, the Global Network on Energy for Sustainable Development, the Renewable Energy Policy Network for the 21st Century and the LPG Challenge, have made efforts to avoid overlap and duplication. Several initiatives/partnerships are aimed at an integrated approach to promoting clean energy services and mitigating climate change in the context of sustainable development. Notable initiatives include the Gleneagles Summit Plan of Action on climate change, clean energy and sustainable development and the Asia-Pacific Partnership for Clean Development and Climate.

91. Since the Johannesburg Summit, there have also been efforts by existing international organizations to work more closely together. OPEC and the International Energy Agency have been meeting since 2002 and have strengthened the International Energy Forum to facilitate dialogue between producers and consumers. Although the Global Forum on Sustainable Energy began prior to the Summit, it has focused on World Summit on Sustainable Development follow-up. The 10-year framework of programmes on sustainable consumption and production (the Marrakech Process) has organized a series of international and regional meetings to support national and regional efforts on a range of topics, including cleaner production. In response to Summit decisions to ensure inter-agency cooperation among United Nations bodies, UN-Energy was established in 2004 under the Chief Executives Board to help ensure coherence in the multidisciplinary response of the United Nations system to the Johannesburg Plan of Implementation by promoting system-wide collaboration in the area of energy.

Box 9

International cooperation for combating ozone layer depletion

The Vienna Convention of 1985 and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer established a framework for reducing and eventually phasing out the production and consumption of chlorofluorocarbons and halons, the primary stratospheric ozone-depleting substances. As of 2005, 189 nations had ratified the Montreal Protocol. The Multilateral Fund, the Protocol's financial instrument to assist developing countries, has disbursed over US$ 1.4 billion for capacity-building and projects to phase out chlorofluorocarbons. At the end of 2003, only 36,294 ozone-depleting potential tons remained of the original 184,532 tons of ozone-depleting substances to be eliminated from the consumption sector under these projects. Halon and chlorofluorocarbon production have been completely phased out, and efforts to end methyl bromide production are under way. Rapid elimination of halon production has been successful in arresting the decrease in stratospheric ozone concentration and the extent of the annual area without ozone that appears over Antarctica. This success was facilitated by the involvement and commitment of industry producers early in the process, and shows the important role that industry can play in achieving international environmental agreements.

Source: UNEP Ozone Secretariat.

92. A long-term strategic vision to shift the climate change issue from what is perceived as predominately an environmental concern to one that is firmly positioned in the broader sustainable development agenda is needed. The centrality of the United Nations Framework Convention on Climate Change as the multilateral framework for enhanced and effective cooperation to combat climate change is of vital importance. Complementary and ambitious actions are required with respect to both mitigation and adaptation. Technology, including renewable energy technologies, plays a key role but must be matched by policies aimed at increasing energy efficiency, reducing emissions and improving the functioning of the carbon market. Action-oriented initiatives and partnerships can help in all these areas. The outcome of the United Nations Climate Change Conference, held in Montreal in December 2005, holds promise for continued international cooperation to deal with the risks of climate change and to secure the validity of the carbon credits generated and traded under the Kyoto Protocol-based international emissions trading beyond 2012. The dual tracks agreed in Montreal for future action, involving binding targets for Annex I Parties beyond 2012 and an open dialogue on long-term cooperative action, requires support by all countries to achieve the objectives of the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

Box 10
Sub-Saharan Africa eliminates leaded fuels

The nations of sub-Saharan Africa completely phased out the production and importation of leaded gasoline in early 2006 following a regional agreement in Dakar in 2001, thus achieving a goal set out in the Programme for the Further Implementation of Agenda 21. This goal was reaffirmed at the World Summit on Sustainable Development in 2002, at which time the Sudan was the only sub-Saharan African country that had completely eliminated leaded gasoline. Technical advice and assistance from the World Summit on Sustainable Development Partnership for Clean Fuels and Vehicles facilitated this and efforts in other regions. There is now widespread international awareness of the importance of phasing out leaded gasoline and the benefits of using catalytic converters, which reduce other pollutants and the formation of smog. Obstacles to the global removal of lead from gasoline are mainly financial, but these have been overcome in most countries by improving access to technical expertise, better financing arrangements for refinery upgrades and modest gasoline price increases. Important lessons from the effort to eliminate leaded fuels include the importance of national and regional commitments and the effectiveness of tax and price incentives and of information sharing.

Source: www.unep.org/pcfv/main/main.htm.

IX. Continuing challenges

93. **Although some progress has been made toward achieving Agenda 21 and Johannesburg Plan of Implementation goals related to the thematic cluster under consideration, considerable work remains. Owing in part to the interlinked nature of the four issues, there are many instances where action taken and measures adopted can have positive impacts in more than one area. Strengthening means of implementation through capacity-building, technology transfer and innovative financing mechanisms can improve implementation in energy for sustainable development, industrial development, air pollution/atmosphere and climate change.**

94. **Pervasive and persistent poverty remains an important obstacle to greater access to modern and cleaner energy services, including electricity, in developing countries. A key challenge is to prioritize and integrate energy into poverty reduction and national sustainable development strategies. Reducing dependence on traditional biomass remains a high priority and a major challenge, which, if met, will have multiple benefits — for women's and children's health, girls' educational attainment and forest conservation. Barriers to wider electricity and gas access include inefficient and highly indebted public providers and inadequate institutional and policy environments for attracting sizeable private sector participation. Regulatory reform and the strengthening of financial markets and mechanisms to raise long-term energy**

infrastructure finance on favourable terms are needed in many countries. Barriers to entry for small-scale energy service providers and independent power producers are still fairly widespread. Inadequate ability to collect revenue due to lack of metering equipment and modern collection procedures still needs to be addressed.

95. **Developing countries face a number of industrial development challenges, depending on their current level of development and industrial structure. These include policy and institutional impediments that stifle entrepreneurial risk-taking and significantly increase the cost of doing business, inadequate infrastructure, including reliable power supplies, to support large-scale industry, a poorly educated and trained labour force, inadequate technological capabilities of local enterprises and weak technology support institutions. While some countries have built up labour-intensive industries, they remain vulnerable to competition from lower-cost producers as trade barriers are further reduced and globalization proceeds, with jobs held by women, who are especially vulnerable. Industrial enterprises frequently lack incentives for adopting cleaner production technologies, and small and medium enterprises also face financial constraints. Weak zoning and land-use planning at the local level frequently result in a mix of industrial and residential land uses, exposing households to a variety of noxious industrial pollutants. Local regulators often feel competing pressures to provide a clean and safe living and working environment and simultaneously to encourage maximum employment creation. Programmes to support the adoption of cleaner technologies and improved labour practices in small and medium-scale enterprises can be a win-win proposition if they facilitate access to global markets.**

96. **Efforts to increase renewable energy use are facing a number of challenges associated with reducing relatively high costs and improving means of implementation. They include the high relative cost of renewable energy; difficulty of assessing resource potential prior to investment; inability of poor people to pay high upfront costs; the lack of consumer and entrepreneurial awareness; the lack of technical capabilities at local levels; and the high perceived risk associated with investing in renewable energy projects. Among the obstacles are the continued subsidies on conventional energy, inadequate local manufacturing capability for components of renewable-based systems in developing countries and lack of capacity to develop fundable project proposals to attract investment.**

97. **Although progress has been made to improve energy efficiency and transfer advanced and cleaner technologies, there are a number of continuing challenges. In many countries there is a lack of market incentive for energy efficiency, inadequate financing and insufficient research and development. Many countries with economies in transition still utilize old, inefficient industrial plants and equipment, and enterprises often cannot finance the acquisition of imported technologies and other costs of renovation. While successes in standards and labelling have been noted, further use of voluntary and mandatory standards would contribute to demand-side management and promote sustainable consumption and production patterns.**

98. **Significant research has facilitated a better understanding of air pollution and the atmosphere, but a number of challenges remain to achieve Agenda 21**

and Johannesburg Plan of Implementation goals. In many countries, the policy and regulatory framework for air pollution control is weak. Emission reduction technologies and cleaner fuels are often too expensive or not available. Research and development and transfer of technology mechanisms are needed to ensure that new and advanced technologies are developed and widely disseminated and adopted. Policy decisions are hampered by the lack of adequate information and data on transboundary air pollution, and enhancing and expanding current monitoring arrangements could serve to overcome this barrier.

99. **A major challenge that remains is the task of mitigating and adapting to climate change. Increased financial assistance and technology transfer, including adaptation technologies, to developing countries to address climate change and adapt to its adverse impacts remains a formidable challenge.**

100. **The multifaceted nature of sustainable development and the close interdependence of the challenges faced in the four areas under review favour the pursuit of an integrated approach as the international community deliberates on ways and means to respond to the challenges.**

Notes

[1] http://www3.who.int/whosis/menu.cfm?path=whosis,burden,burden_estimates,burden_estimates_2002N,burden_estimates_2002N_2002Rev,burden_estimates_2002N_2002Rev_Region&language=english.

[2] Africa region statement to the fourteenth session of the Commission on Sustainable Development, Addis Ababa, Economic Commission for Africa (2005).

[3] Ajey Chandra et al., *Oil and Gas Journal*, vol. 103 (2005).

[4] National report of Denmark.

[5] International Energy Agency, *World Energy Investment Outlook*, OECD (2003).

[6] National report of Kiribati.

[7] Statement by Suo Lisheng, Chinese Vice-Minister of Water Resources, United Nations Symposium on Hydropower and Sustainable Development, Beijing (2004).

[8] See R. Hausmann, L. Pritchett and D. Rodrik, "Growth Accelerations", John F. Kennedy School of Government, Harvard University, revised August 2005.

[9] See Department of Economic and Social Affairs, *Trends in Sustainable Development*, 2006, forthcoming, for details.

[10] S. Lall, with the assistance of E. Kraemer-Mbula, "Is African industry competing?", Working Paper No. 121, QEH Working Paper Series, University of Oxford (2005).

[11] R. Hausmann, D. Rodrik and A. Velasco, "Growth Diagnostics", John F. Kennedy School of Government, Harvard University, Cambridge, MA, revised March 2005.

[12] D. Rodrik, "Industrial Policy for the Twenty-First Century", JFK School of Government, Harvard University, September 2005.

[13] United Nations Conference on Trade and Development, "Environmental requirements and market access for developing countries: the case of electrical and electronic equipment (EEE)", unedited background paper for UNCTAD-United Nations Economic and Social Commission for Asia and the Pacific Workshop on exchanging national experiences among the principal

exporting developing countries — environmental requirements and market access for electrical and electronic goods, Bangkok, 25-27 May 2005.

[14] Lead, mercury, cadmium, hexavelent chromium, polybrominated biphenyls or polybrominated diphenyl ethers.

[15] See note 2.

[16] International Energy Agency, *Oil crises and climate challenges: thirty years of energy use in IEA countries*, OECD, Paris (2004).

[17] A. Miketa and P. Mulder, "Energy productivity across developed and developing countries in ten manufacturing sectors: patterns of growth and convergence", *Energy Economics*, vol. 27 (2005).

[18] L. Price, D. Phylipsen and E. Worrell, "Energy use and carbon dioxide emissions in the steel sector in key developing countries", Lawrence Berkeley National Laboratory (LBNL-46987) (2001).

[19] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,menuPK:578075~pagePK:64168427~piPK:64168435~theSitePK:578069,00.html.

[20] National report of Lithuania.

[21] National report of Hungary.

[22] National report of Uganda.

[23] Christina Galitsky, et al., "Tax and fiscal policies for promotion of industrial energy efficiency: a survey of international experience", Lawrence Berkeley National Laboratory, 2005.

[24] Ibid.

[25] Beijing Declaration on Hydropower and Sustainable Development, United Nations Symposium on Hydropower and Sustainable Development, Beijing, October 2004.

[26] Supercritical pulverized combustion is a clean coal process that reduces emissions in the combustion cycle.

[27] Synfuels refers to synthetic petroleum products made from coal, condensates or natural gas.

[28] Intergovernmental Panel on Climate Change, *Special Report on Carbon Dioxide Capture and Storage* (Technical Summary) (2005).

[29] International Monetary Fund, *Global Financial Stability Report* (September 2005).

[30] United Nations Conference on Trade and Development, *World Investment Report*, Geneva (2005).

[31] For example, in 2002 Ecuador began a second phase of reforms to attract private sector investment in electricity generation.

[32] World Bank, "Private Power Projects", 2004.

[33] International Energy Agency, *World Energy Investment Outlook, 2003 Insights*, OECD (Paris, 2003).

[34] Vijay Modi, "Energy services for the poor", UN Millennium Project, November 2004.

[35] National report of the United States of America.

[36] Investment totals of about US$ 130 billion have been reported. Core mitigation investments are investments self-defined by the source of investment as being made for emission mitigation purposes, as well as investments made in sectors or projects that by their nature are likely to reduce emissions, such as renewable energy (see FCCC/SBI/2005/INF.7).

[37] Certified emission reductions are a unit of greenhouse gas emission reductions issued pursuant to the Clean Development Mechanism of the Kyoto Protocol, and measured in metric tons of CO_2 equivalent.

[38] Statement by the United Nations Framework Convention on Climate Change representative to the General Assembly, November 2005.

[39] Submission of the Business and Industry Major Group to the fourteenth session of the Commission on Sustainable Development World Business Council for Sustainable Development (2005).

[40] Annex I parties to the FCCC include industrialized countries that were members of OECD in 1992, plus countries with economies in transition, including the countries of the former USSR and several Central and Eastern European countries.

[41] Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen.

[42] Council of Arab Ministers Responsible for the Environment, Report on the Arab regional implementation Meeting, Cairo, November 2005.

[43] E/ECE/1442, 17 January 2006.

[44] ESD/RIMAP/2006/Rep., 27 January 2006.